YAKEEN

Lecture - 6

MOTION WITH CONSTANT ACCELERATION

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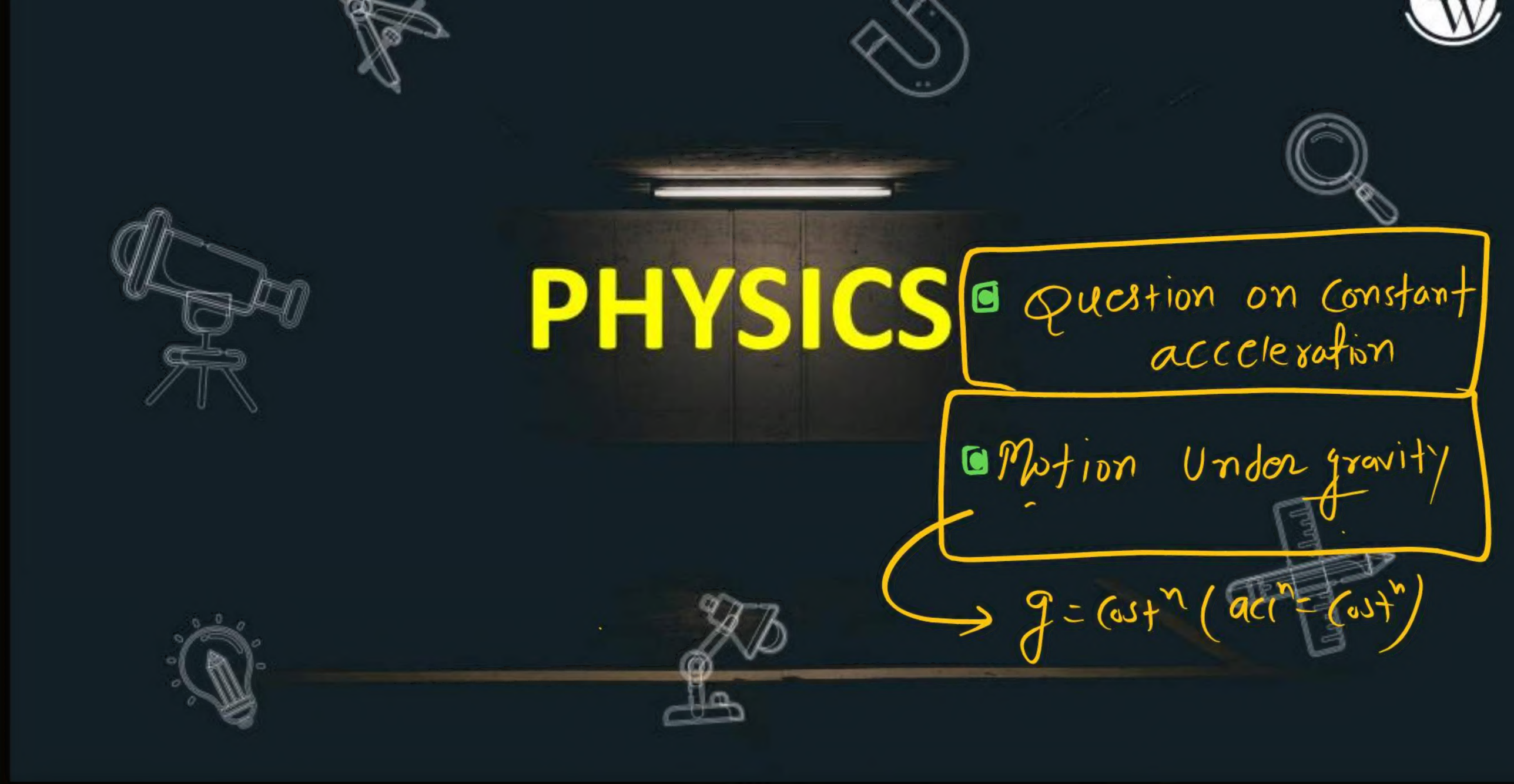

PHYSICS
Question on Constant acceleration
Motion Under gravity
g = const^n (acc^n = const^n)

~~-ve acc^n mince retardation~~

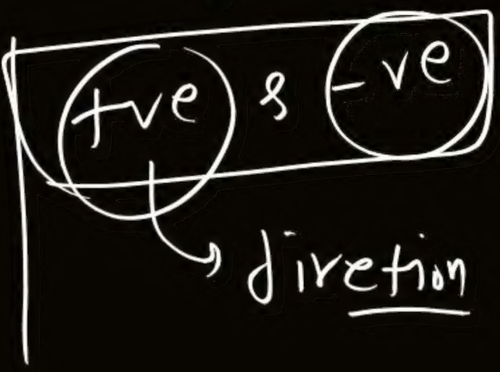
retardation → To slow down (धीरे होना)

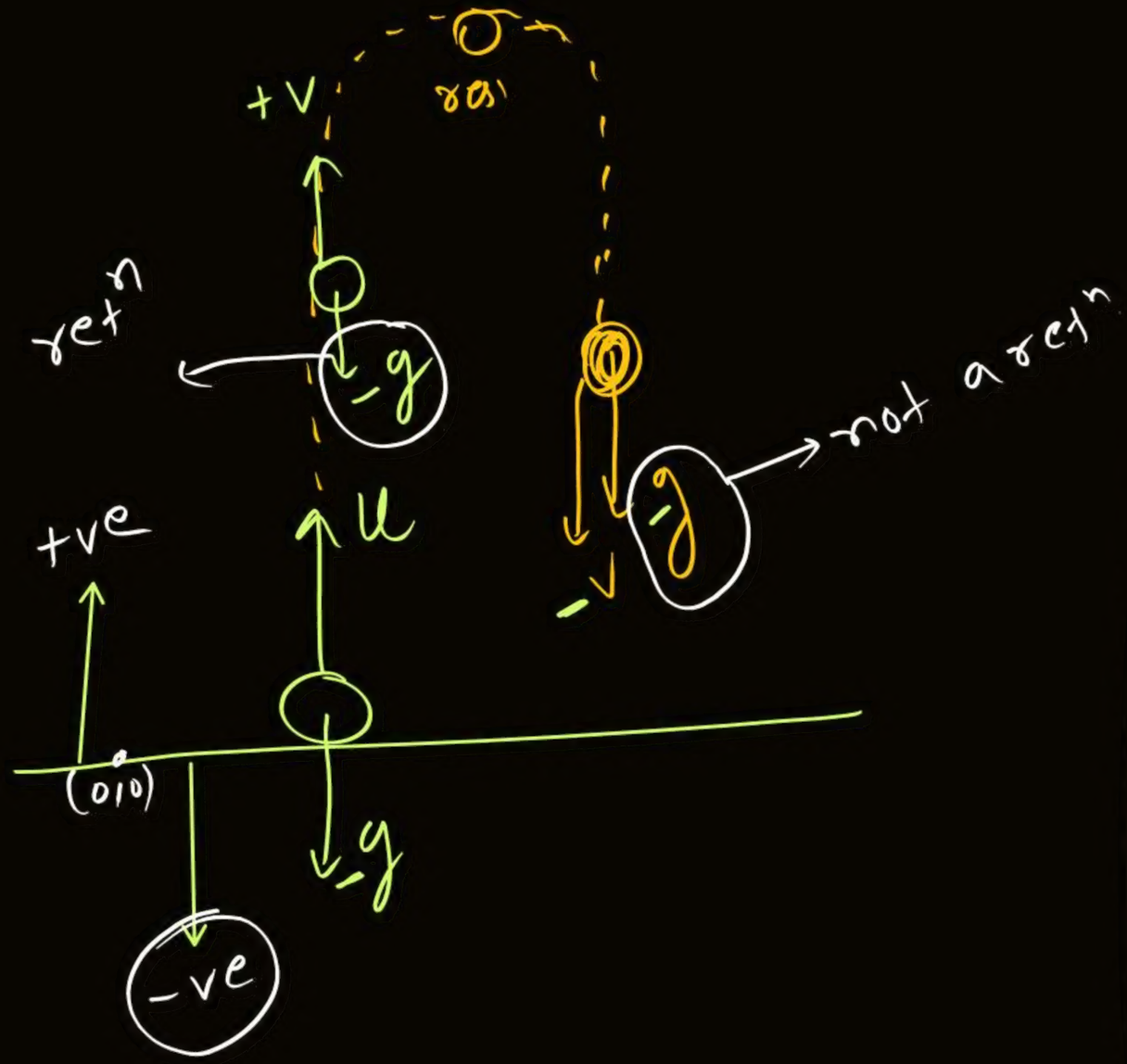
Speed ↓

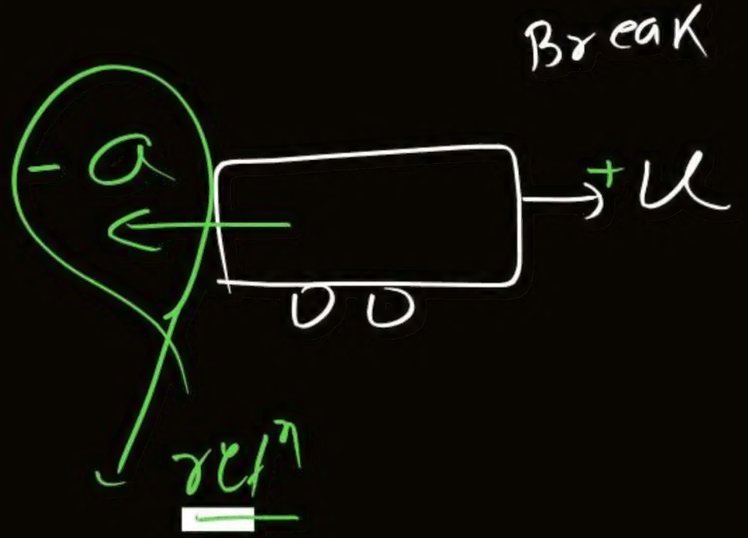
(मंदन)

Metal retardation

When acc^n (force) opposite to the motion (velocity)




+v
rest
ref^n
-g
u
+ve
(0,0)
-g
-ve
-g
not a ref^n


Break
-a
+u
ref^n

rest ($u=0$)
Consⁿ acc^{n}

$$S_{1\text{-sec}} : S_{2\text{-sec}} : S_{3\text{-sec}} = x : 4x : 9x : 16x : 25x : 36x : 49x : 64x : 81x : \text{long}$$

$$S_{t\,\text{sec}} : S_{(2t)} = x : 4x$$

$$S_{1^{st}} : S_{2^{nd}} : S_{3^{rd}} = x : 3x : 5x : 7x : 9x : 11x$$

$$S_{t\,\text{sec}} : S_{\text{next sec}} = x : 3x$$

Velocity of object $v = \sqrt{25 - 8x}$ find initial velocity and acceleration.

$v = \sqrt{(25-8x)} = (25-8x)^{1/2}$

Basic method

$a = v\frac{dv}{dx}$

$= (\sqrt{25-8x}) \times \frac{1}{2}(25-8x)^{\frac{1}{2}-1} \times -8$

$= \sqrt{25-8x} \times \frac{1}{2} \times (-8) \times \frac{1}{(25-8x)^{1/2}}$

$a = -4\ m/s^2$

AIPMT / NEET JEE

MR^* $\quad a = \text{const}^n$

$x \propto t^2 \;/\; v \propto t^1 \;/\; v \propto \sqrt{x}$

$V^2 = 25 - 8x$

$\Rightarrow V^2 = u^2 + 2ax$

$2a = -8$

$a = -4\ m/s^2$

$u = 5\ m/s$

If velocity of object $v = k\sqrt{x}$ then find position of object as a function of time.

(a) $x \propto t^2$ (b) $x \propto t$ (c) $x \propto \sqrt{t}$ (d) $x \propto t^{-1/2}$ IIT - 2006

Soln "$v = k\sqrt{x}$"

$$\frac{dx}{dt} = k\sqrt{x}$$

$$\int \frac{dx}{\sqrt{x}} = k\int dt$$

$$\frac{x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1} = kt$$

$$\frac{x^{\frac{1}{2}}}{\frac{1}{2}} = kt$$

$$x^{1/2} = \frac{kt}{2}$$

$$x = \frac{k^2t^2}{4}$$

$x \propto t^2$

1 mR*
$v = k\sqrt{x}$
$a = \text{Constant}$

⑧ $v \propto x^2$ then find Rel^n b/w x/t

$$V = Kx^2$$

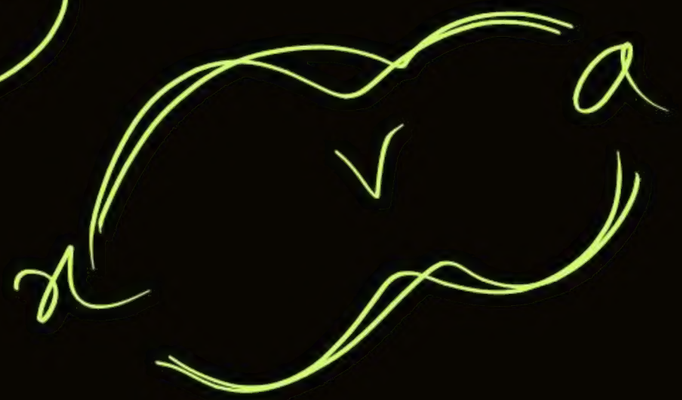
$$\frac{dx}{dt} = Kx^2$$

$$\int \frac{dx}{x^2} = \int K\,dt$$

$$\frac{x^{-2+1}}{-2+1} = Kt$$

$$\frac{1}{x} = -Kt$$

$$x = -\frac{1}{Kt}$$



$$\vec{v} = \vec{u} + at$$

$$\vec{s} = ut + \frac{1}{2}at^2$$

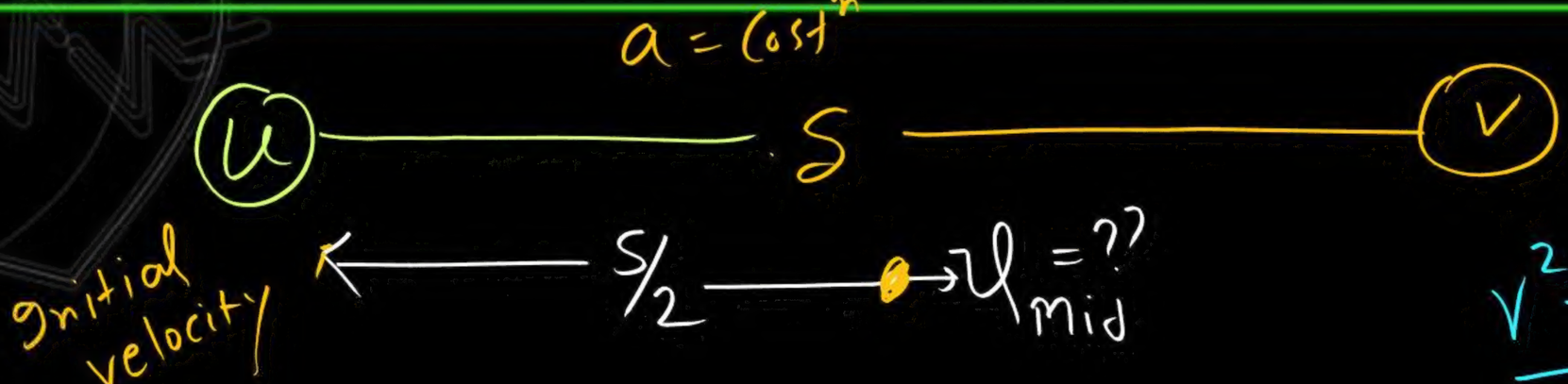
$$v^2 - u^2 = 2as$$

$$s_n = u + \frac{a}{2}(2n-1)$$

$$v_{Avg} = \frac{\vec{u} + \vec{v}}{2} = \frac{s}{t}$$

$$s = \left(\frac{u+v}{2}\right)t$$

Object starts his motion from u and constant acceleration then find velocity at mid point if velocity at end point is V.



3rd equation of motion for compt Jon.

$$v^2 - u^2 = 2as \quad - (i)$$

$$v_{mid}^2 - u^2 = 2a\frac{s}{2} \quad - (ii)$$

$$\frac{v^2 - u^2}{v_m^2 - u^2} = \frac{2}{1}$$

$$v^2 - u^2 = 2v_m^2 - 2u^2$$

$$v^2 + u^2 = 2v_m^2$$

$$v_{mid} = \sqrt{\frac{v^2+u^2}{2}}$$

$$v_{mid} = \sqrt{\frac{u^2+u^2}{2}} \Rightarrow a_n = (\text{Cost})^n$$

$v_{max} = 0$

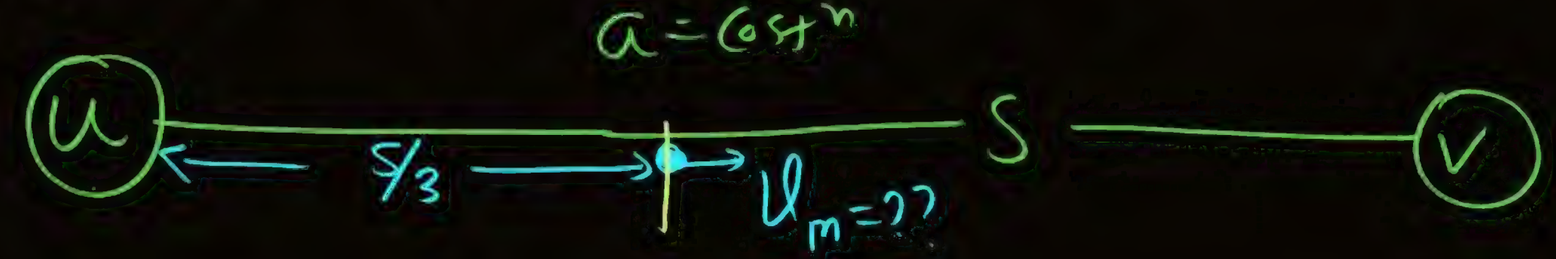
$$v_{mid} = \sqrt{\frac{u^2+0}{2}} = \frac{u}{\sqrt{2}}$$

Ans

u

$a = g = \text{Cost}^n$

Object starts his motn with velocity u & Const^n acc^n after displ^m S its velocity is V then find velocity at one 3rd dist^m.



$$\frac{V^2 - u^2 = 2as}{V_m^2 - u^2 = 2a\frac{s}{3}} \Rightarrow V^2 - u^2 = (v_m^2 - u^2)3$$

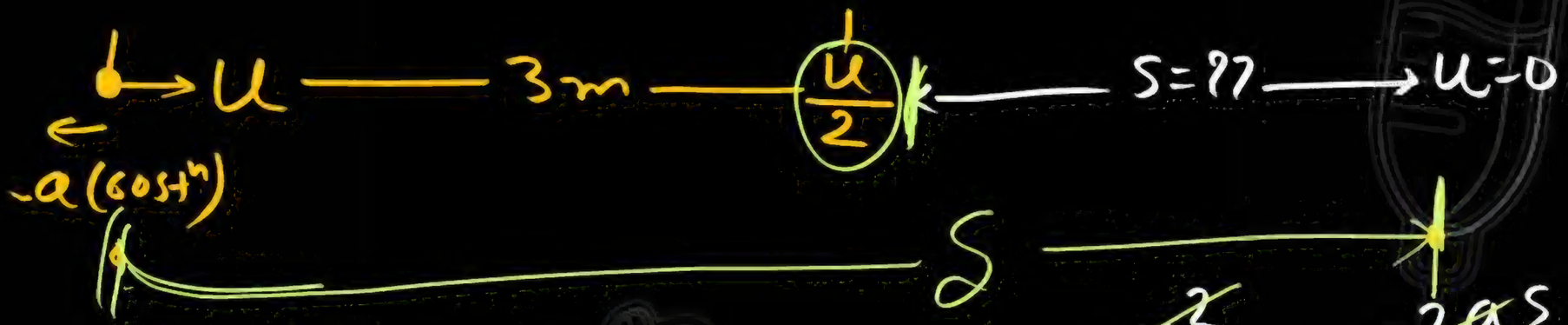
$$3v_m^2 = V^2 + 3u^2 - u^2$$

$$v_m^2 = \frac{V^2 + 2u^2}{3}$$

$$v_m = \sqrt{\frac{V^2 + 2u^2}{3}}$$

Object starts his motion from u and due to constant retardation it loose half velocity after a displacement of 3m then find further displacement after which object comes to at rest.

3rd eq



Compt Journey

$$0 - u^2 = -2as \quad -(1)$$

$$\frac{u^2}{4} - u^2 = -2a3 \quad (ii)$$

$$\frac{-u^2}{+3u^2/4} = \frac{-2as}{-2a(3)}$$

$$\frac{4}{3} = \frac{s}{3}$$

$s = 4$ ✗

1m

Object starts his motion from rest and constant acceleration then find ratio of displacement in 6^{th} sec to 6-sec.

Sol^n

$$S_{n^{th}} = u + \frac{a}{2}(2n-1)$$

$$= \frac{a}{2}(11)$$

$$S_n = \cancel{ut}^{0} + \frac{1}{2}at^2$$

$$= \frac{1}{2}a(6)^2 = 36\left(\frac{a}{2}\right)$$

$$\frac{S_{6^{th}\,sec}}{S_{6\text{-}sec}} = \frac{11\cancel{a}/\cancel{2}}{36\cancel{a}/\cancel{2}} = \frac{11}{36}$$

MR^2

1 3 5 7 9 11 13

$\frac{11}{36}m$

Object starts his motn from rest and constant accn then find ratio of disp in n-sec to n^{th} sec.

$$S_{n\text{-sec}} = u\cancel{n} + \frac{1}{2}a(n)^2$$

$$\frac{S_{n\text{-sec}}}{S_{n^{th}}} = \frac{\frac{1}{2}a(n)^2}{\frac{1}{2}a(2n-1)} = \frac{n^2}{(2n-1)}$$

Object starts his motion from rest and constant acceleration takes time T for s displacement then find time taken for 1st half and 2n half displacement.

Compt Journey 2nd eqn

$$s = \frac{1}{2}aT^2 \quad -(i)$$

1st half

$$\frac{s}{2} = 0 + \frac{1}{2}at_1^2 \quad -(ii)$$

$$\frac{s/2}{s} = \frac{t_1^2}{T^2}$$

(ii)/(i)

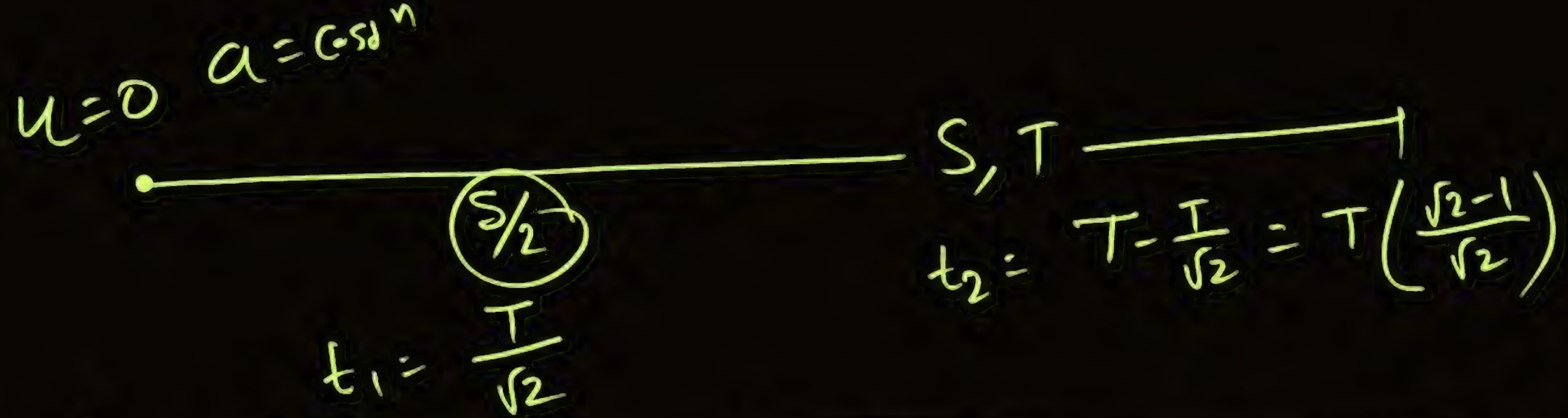
$$2t_1^2 = T^2$$

$$t_1 = \sqrt{\frac{T^2}{2}} = \frac{T}{\sqrt{2}}$$

$$\frac{s}{2} = \frac{1}{2}at_2^2 \quad -(iii)$$

$t_1 + t_2 = T$

$$t_2 = T - \frac{T}{\sqrt{2}}$$



$t_1 = \frac{T}{\sqrt{2}}$

$t_2 = T - \frac{T}{\sqrt{2}} = T\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)$

$$\frac{t_1}{t_2} = \frac{\frac{T}{\sqrt{2}}}{\frac{T}{\sqrt{2}}(\sqrt{2}-1)}$$

$$\frac{t_1}{t_2} = \frac{1}{\sqrt{2}-1}$$

$t_1 : t_2 : t_3 : t_4 : t_5 =$

For equal distⁿ Intval → from rest & const^n acc^n

$= \sqrt{1}-\sqrt{0} : \sqrt{2}-\sqrt{1} : \sqrt{3}-\sqrt{2} : \sqrt{4}-\sqrt{3}$

$= 1 : \sqrt{2}-1 : \sqrt{3}-\sqrt{2} : \sqrt{4}-\sqrt{3}$

An object accelerates from rest to a velocity 27.5 m/s in 10 sec then find distance covered by object in next 10 sec :

(a) 550 m

(b) 137.5 m

(c) 412.5 m

(d) 275 m

$S = \left(\frac{u+v}{2}\right)T = \left(\frac{0+27.5}{2}\right) \times 10 = \frac{275}{2}$

for 10 sec

$S' = 3 \times \frac{275}{2} = \frac{825}{2} = 412.5\text{m}$

A motor car moving with a uniform speed of 20 m/sec comes to stop on the application of brakes after travelling a distance of 10 m. Its acceleration is :

(a) $20\ m/sec^2$

(b) $-20\ m/sec^2$

(c) $-40\ m/sec^2$

(d) $+2 m/sec^2$

* $\vec{u} = +20 m/s$

$v_f = 0$

$v^2 - u^2 = 2as$

$0 - 400 = 2 \times a \times 10$

$a = -20 m/s^2$

The velocity of a body moving with a uniform acceleration of $2 m/sec^2$ is 10 m/sec. Its velocity after an interval of 4 sec is :

(a) 12 m/sec

(b) 14 m/sec

(c) 16 m/sec

(d) 18 m/sec

$a = 2 m/s^2$

$u = 10 m/s$

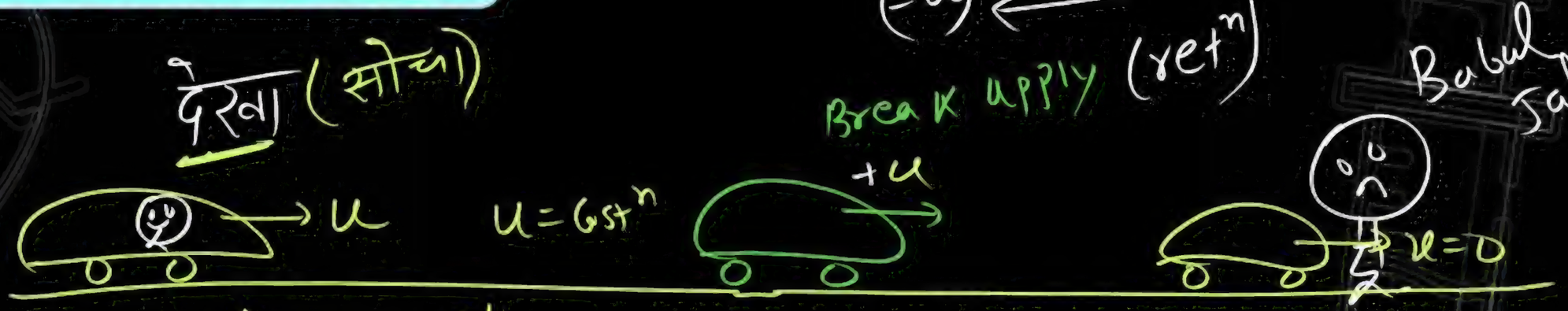
$t = 4 sec$

$v = u + at$

$= 10 + 2 \times 4$

$= 18 m/sec$

STOPPING DISTANCE



$t = \frac{s'}{u}$

↳ Reaction time

- Stopping distance

3^{rd} eqⁿ of motion

$v^2 - u^2 = 2as$

$0 + u^2 = 2(+a)S$

$S = \frac{u^2}{2a}$ #

$$S = \frac{u^2}{2a}$$

$v^2 = u^2 = 2as$

$* S \propto (u)^2$

$u = 50\,m/s$; Break $\longrightarrow$ 40m stopping distⁿ.

$u = 100\,m/s$; Break $\longrightarrow$ 160 m Ans

A car moving with a speed of 50 km/hr, can be stopped by brakes after at least 6m. It the same car is moving at a speed of 100 km/hr, the minimum stopping distance is :

(a) 6 m
(b) 12 m
(c) 18 m
(d) 24 m

$S \propto (u^2)$

$$S_1 = \frac{u_1^2}{2a} \quad -(1)$$

$$S_2 = \frac{u_2^2}{2a} \quad -(1)$$

$$\frac{S_1}{S_2} = \frac{u_1^2}{u_2^2}$$

$$S = \frac{u^2}{2a} \quad -(1)$$

$$\frac{6}{S_2} = \frac{(50)^2}{(100)^2} = \frac{50 \times 50}{100 \times 100}$$

$$6 \times 4 = S_2$$

A body of mass 10 kg is moving with a constant velocity of 10 m/s. When a constant force acts for 4 seconds on it, it moves with a velocity 2 m/sec in the opposite direction. The acceleration produced in it is :

(a) $3\ m/sec^2$

(b) $-3\ m/sec^2$

(c) $0.3\ m/sec^2$

(d) $-0.3\ m/sec^2$

$u_i = +10\ m/s$

$u_f = -2\ m/s$

$$a = \frac{u_f - u_i}{\Delta t}$$

$$= \frac{-2 - (10)}{4}$$

$$a = \frac{-12}{4} = -3\ m/s^2$$

The initial velocity of the particle is 10 m/sec and its retardation is $2m/sec^2$. The displ^m moved by the particle in 5^{th} second of its motion is :

(a) 1 m
(b) 19 m
(c) 50 m
(d) 75 m

⓪ If speed of object is decreasing then correct option is

(a) acc^n is +ve ✗
(b) acc^n is -ve ✗
(c) acc^n is zero ✗
(d) ✓ acc may be decreasing

$u = +10 m/s$

$a = -2 m/s^2$

$$S_{nth} = u + \frac{a}{2}(2n-1)$$

$$= 10 - \frac{2}{2}(2\times5-1) = 10-9 = 1m$$

A body starts from rest. What is the ratio of the distance travelled by the body during the 4^{th} and 3^{rd} second :

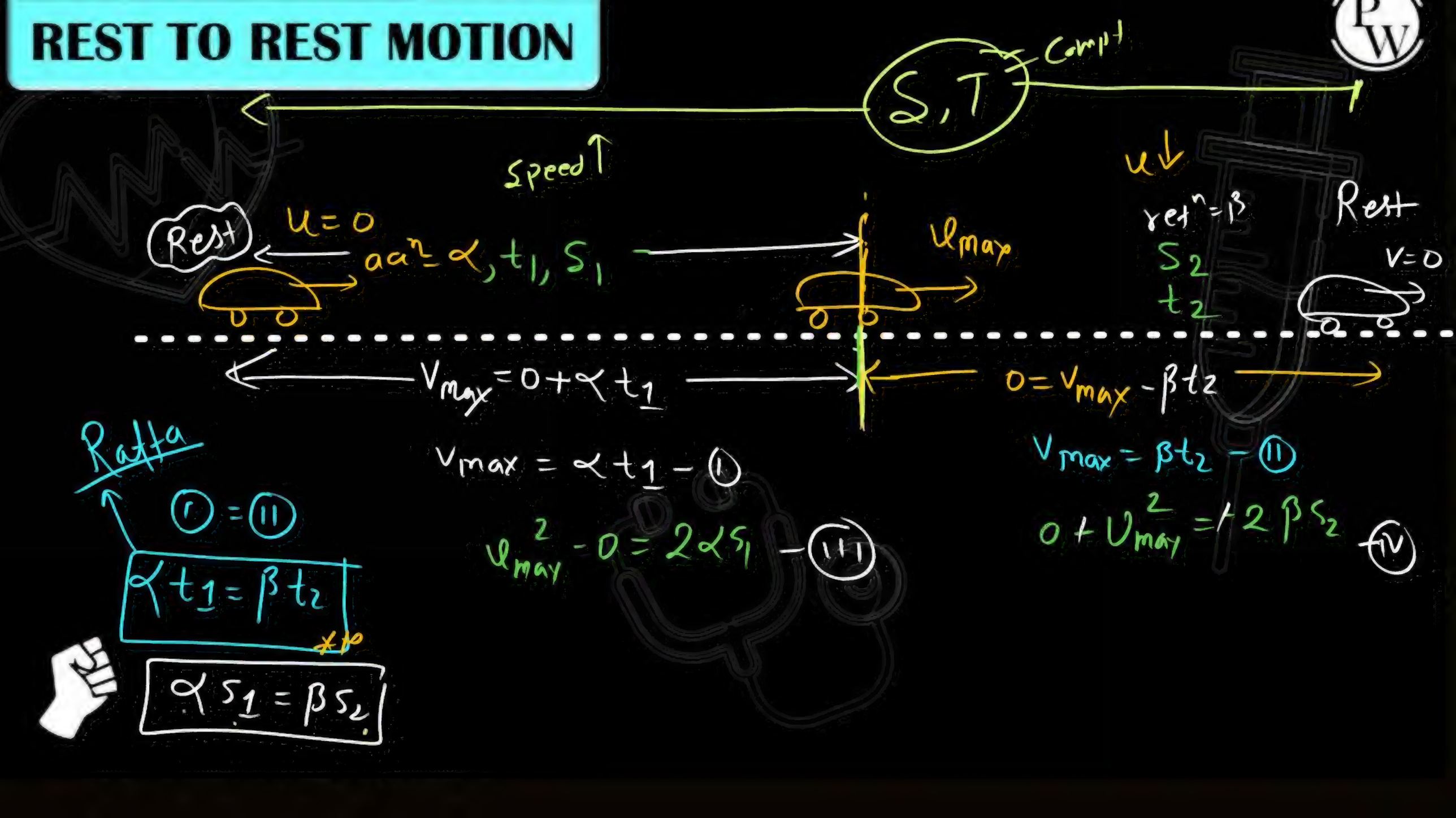
(a) 7/5

(b) 5/7

(c) 7/3

(d) 3/7

REST TO REST MOTION



$$t_1 + t_2 = T$$

$$\frac{v_{max}}{\alpha} + \frac{v_{max}}{\beta} = T$$

$$v_{max}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right) T$$

$$v_{max}\left(\frac{\alpha+\beta}{\alpha\cdot\beta}\right) T$$

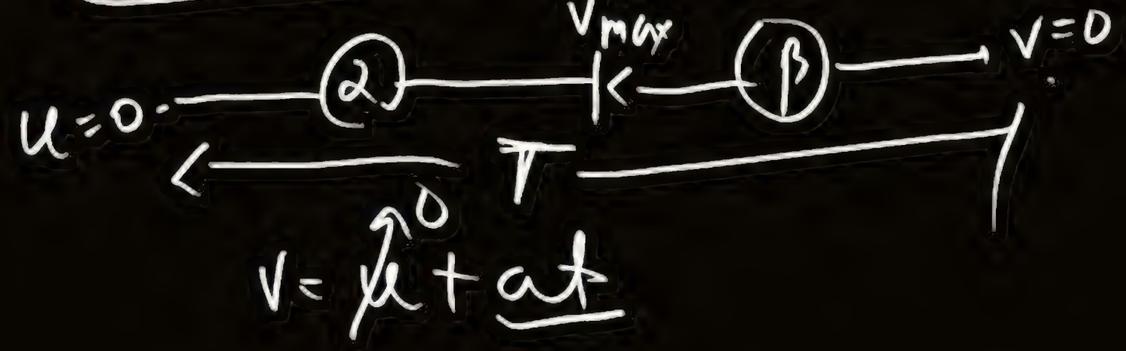
$$v_{max} = \left(\frac{\alpha\cdot\beta}{\alpha+\beta}\right) T$$

$$S = \frac{1}{2}\left(\frac{\alpha\cdot\beta}{\alpha+\beta}\right) T^2$$

Recall

dimension

$$= \frac{a(cm)}{(a(cm))^2}\left(\frac{1}{a(cm)}\right)$$



$$v = u + at$$

$$\alpha t_1 = \beta t_2$$

$$\alpha s_1 = \beta s_2$$

$$u_{max} = \left(\frac{\alpha \cdot \beta}{\alpha + \beta}\right) T$$

$$S = \frac{1}{2}\left(\frac{\alpha \beta}{\alpha + \beta}\right) T^2$$

$v_i = +10$ m/s

$a = -2$ m/s^2 (Backward)

(i) Find distance in 6- sec

(ii) find displacement in 6-sec

$a = -2$ m/s^2

$S = ut + \frac{1}{2}at^2$

$= 10 \times 6 - \frac{1}{2} \times 2 \times (6)^2$

$= 60 - 36$

$S = 24$ m

$V = u + at$

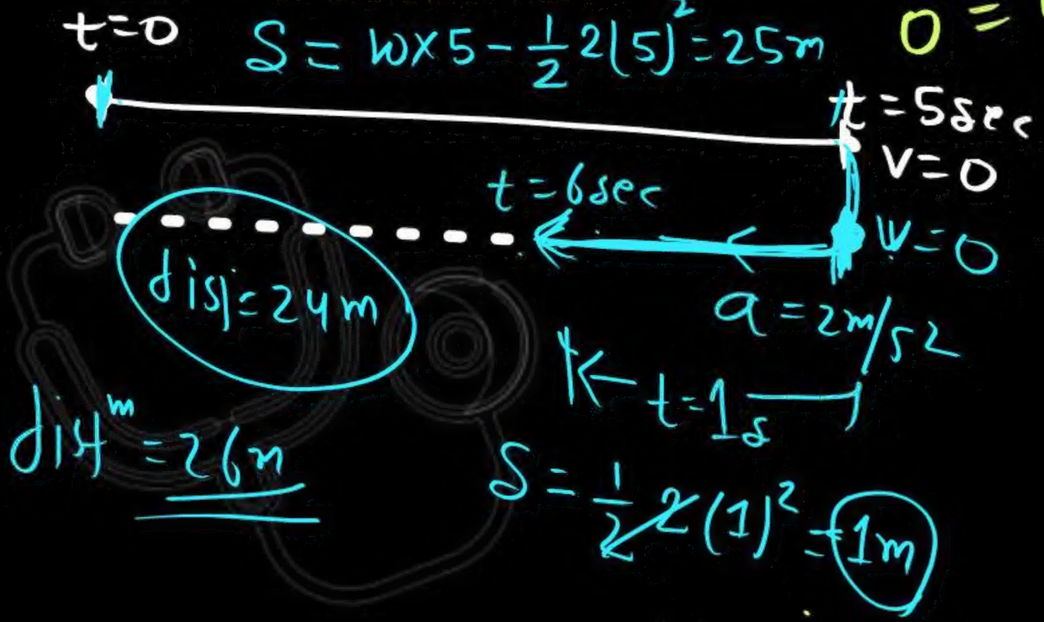
$V = 10 - 2 \times t$

$0 = 10 - 2t$

$10 = 2t$

$t = 5$ sec

Distance



$v = +10$ m/s

$a = -2$ m/s^2

Find distance in 6– sec

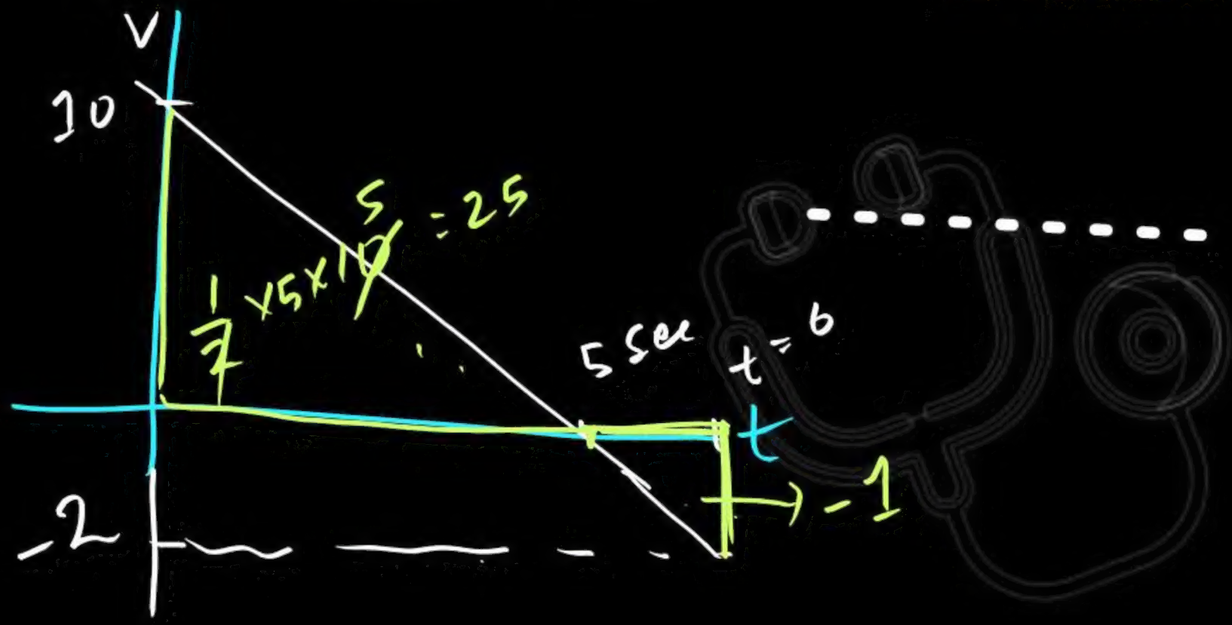
$V = u + at$

$u = 10 - 2t$

$y = mx + c$

Distance

$v/t \rightarrow$ Area




thanks
for watching